

# Groundwater Influence on River Water Temperature

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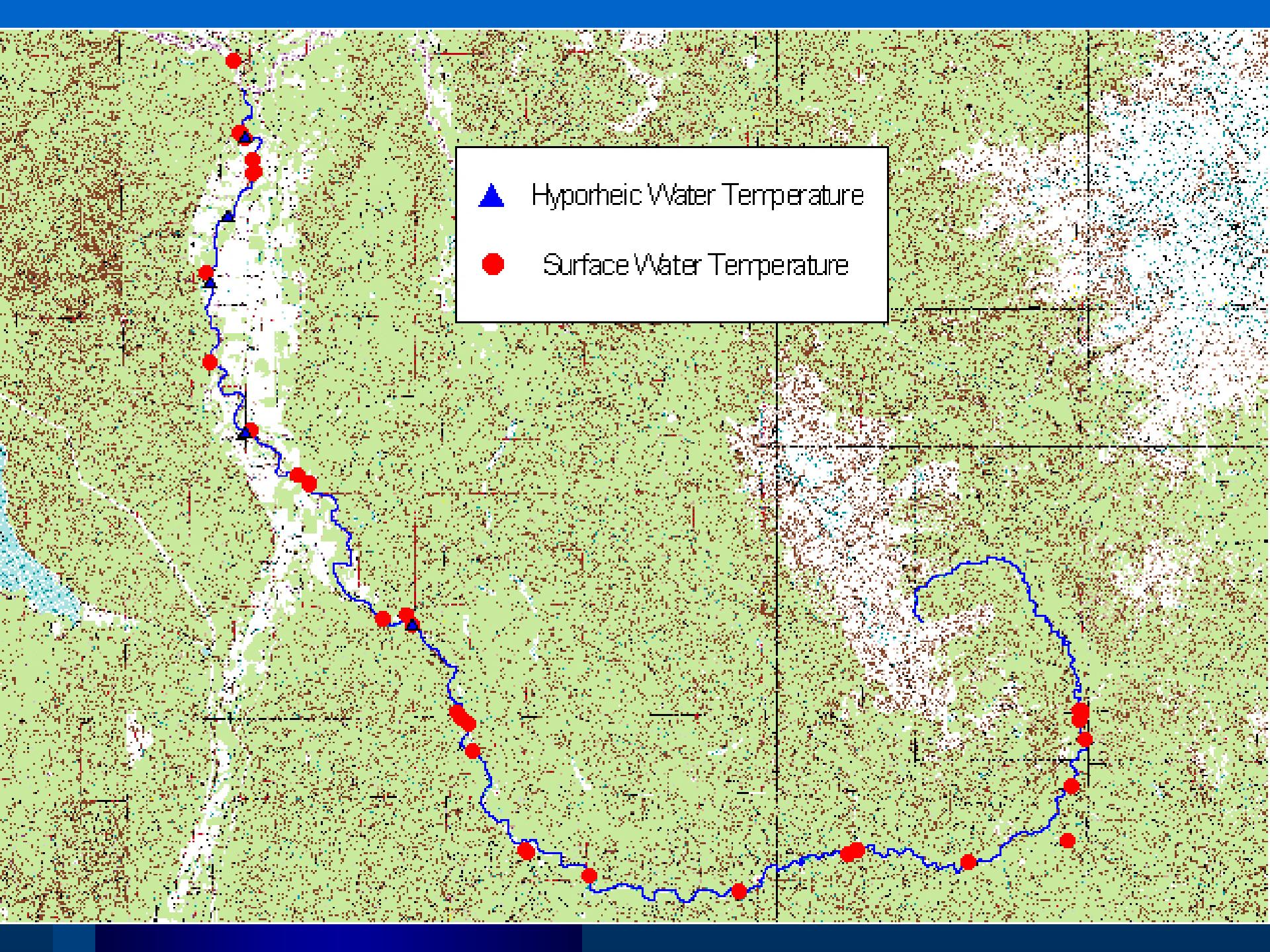
# Background

- **South Fork Nooksack River provides habitat for ESA listed Puget Sound Chinook**
- **High summer water temperatures are detrimental to Chinook recovery**
- **Enhanced understanding of the factors contributing high temperatures is sought, to accomplish:**
  - Better management to achieve reduction of water temperature in summer months
  - Identification of locations for habitat enhancement to maximize utility for salmonids

# Presentation Outline

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- South Fork Watershed characterization
- Water temperature influencing processes
- Data collected
- Interpretation of predominant processes
- Implications for habitat restoration



# South Fork Watershed Characterization

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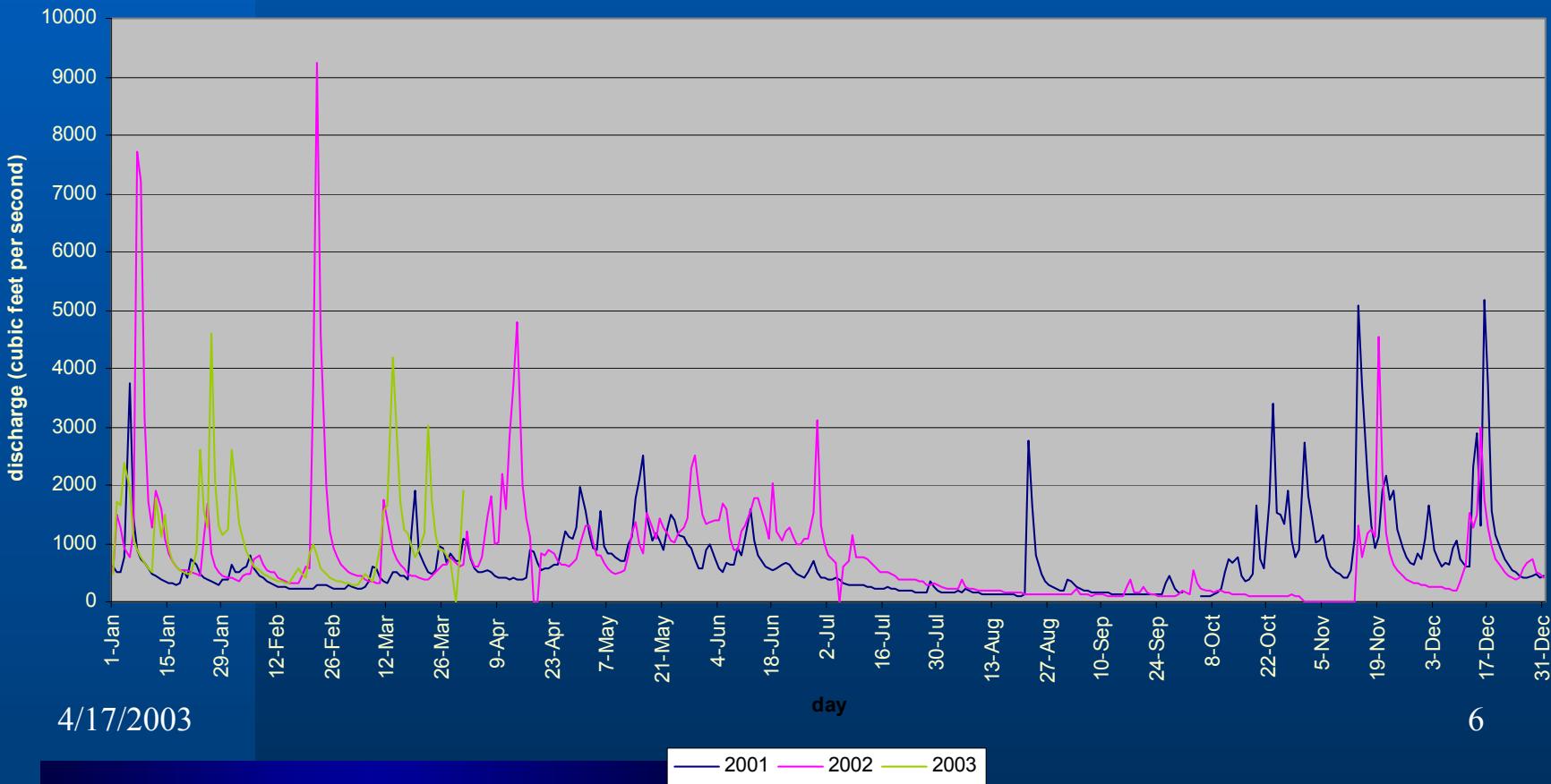
## Hydrology

- Twin Sisters maximum 7,000 ft to 200 ft elevation at confluence with the North Fork
- Flows Range from 59 to 22,400 cfs (as measured at RM14) over 65 yr record

Average Flow 900 cfs annual

- River length 39 miles (34 miles below Wanlick Creek confluence)
- Watershed 187 square miles

# South Fork Discharge at RM 14.6





4/17/2003

7

# Geologic Progression

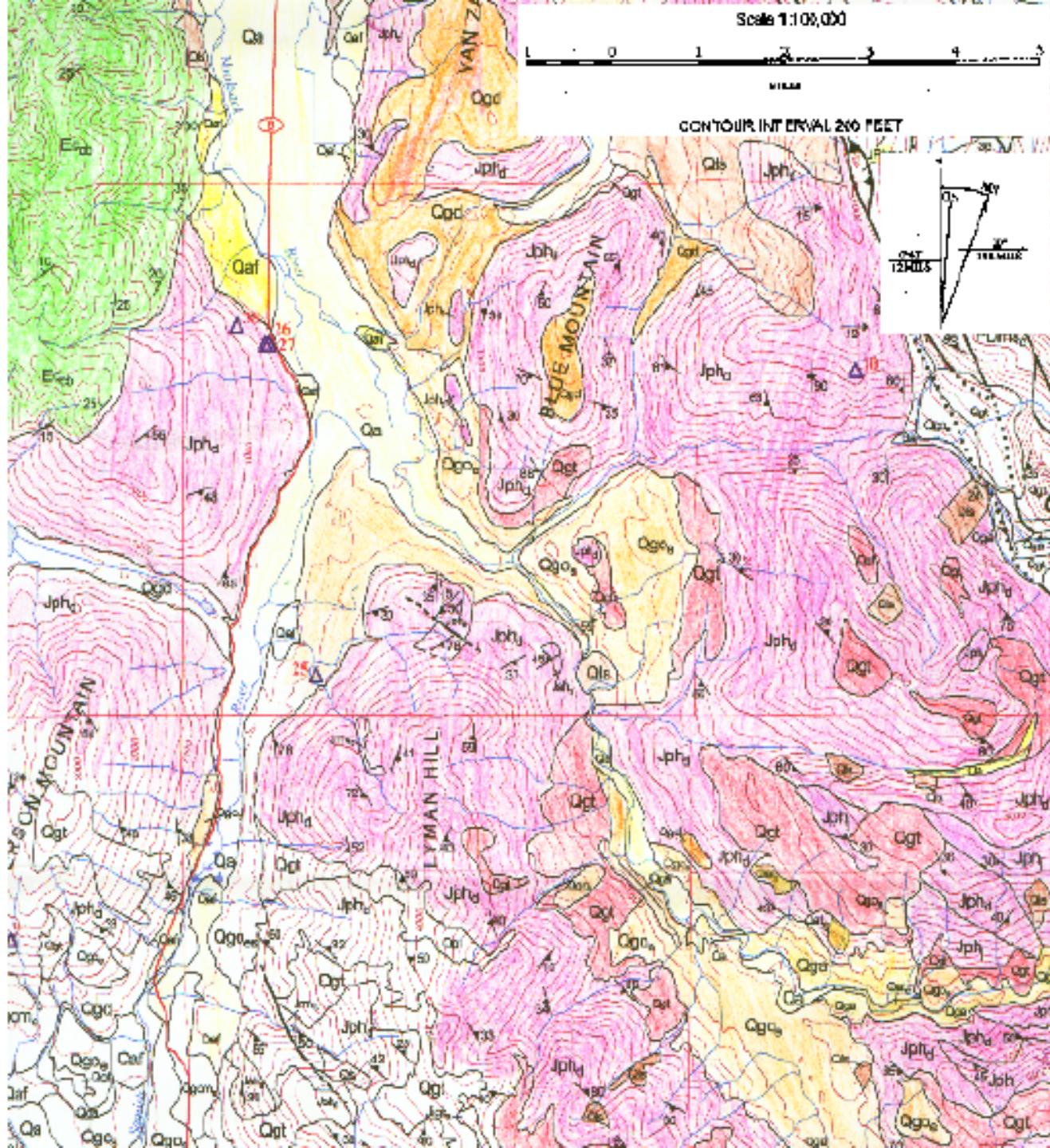
- Upper Watershed
  - Metamorphic Rocks
  - Glacial Deposits
- Lower Watershed
  - Eocene Chuckanut Fmtn
  - Glacial Deposits
  - Lahar
  - Alluvium



Scale 1:10,000



CONTOUR INTERVAL 200 FEET



## Quaternary Sedimentary Nonglacial Deposits

- Qasf alluvium
- Qp peat
- Qaf alluvial fan deposits
- QIs landslide deposits

## Quaternary Sedimentary Glacial Deposits

- Qgd undifferentiated glacial deposits

## Everson Interstade

- Qgo Recessional Outwash

## Vashon Stade

- Qgt Till
- Qga Advance Outwash

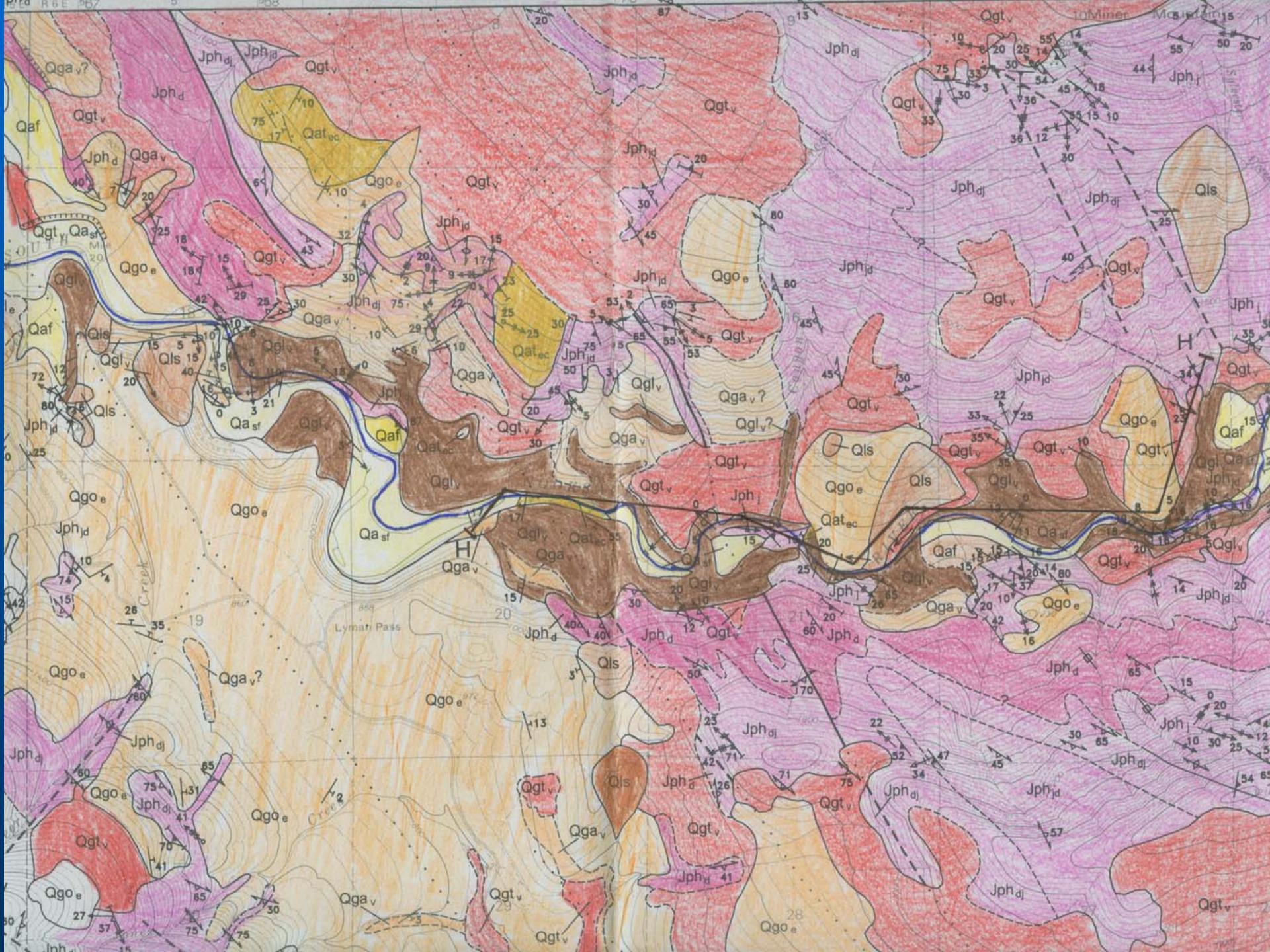
## Qgl Glacio lacustrine deposits

## Evans Creek Stade

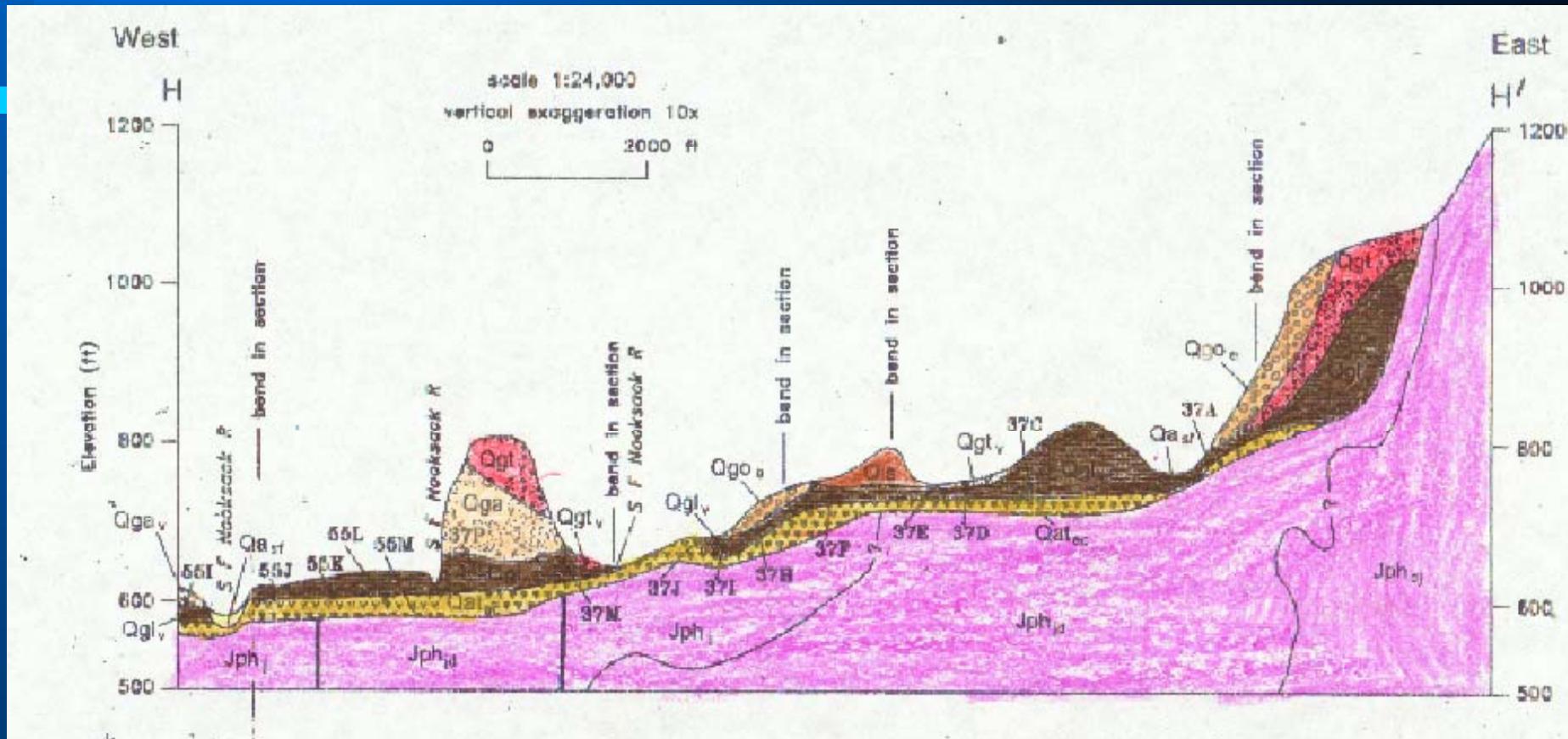
- Qatc Till (very dense "till" pavement)

## Mesozoic Metamorphic Rocks

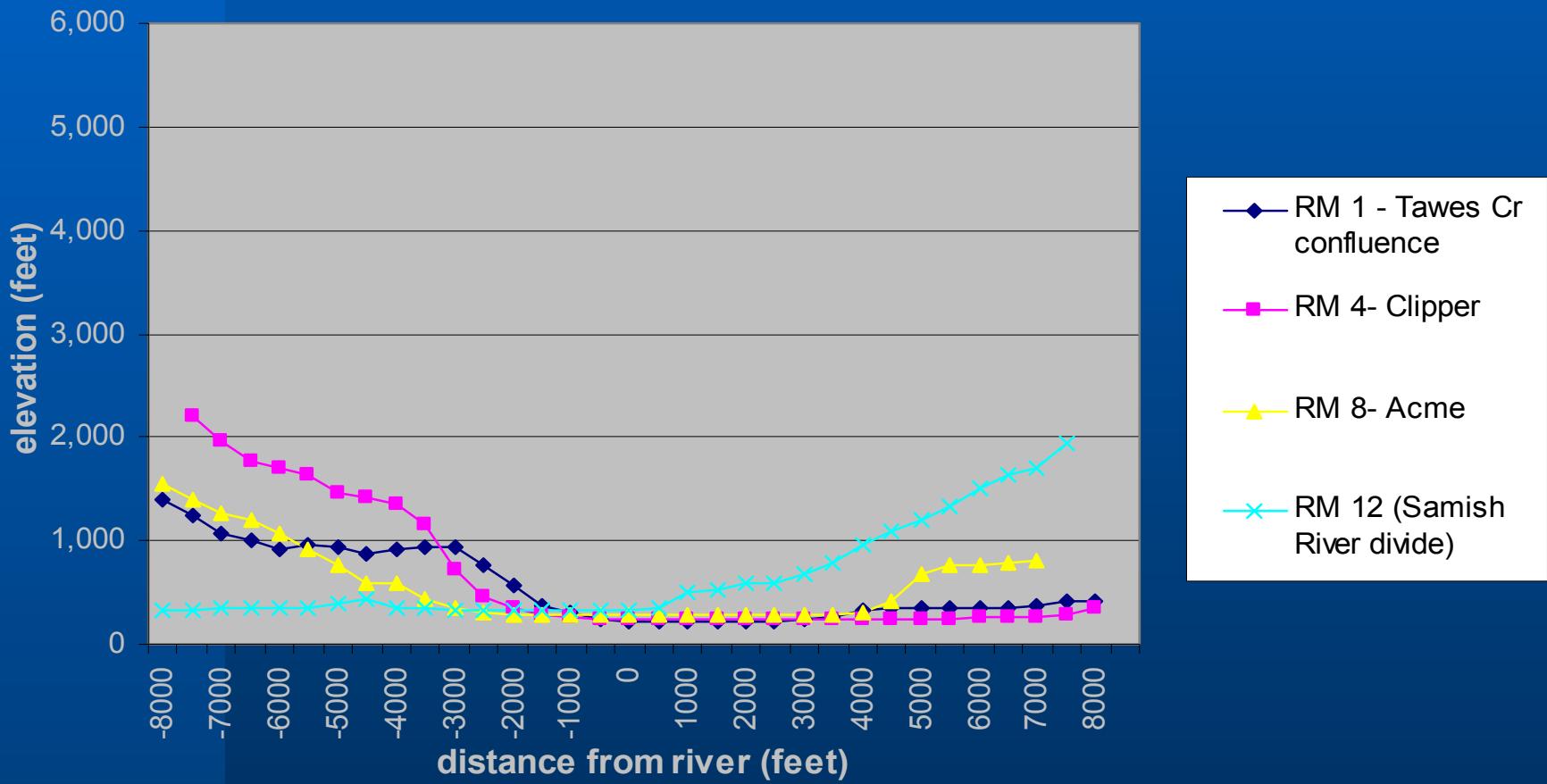
- Jphd Darrington Phyllite
- Jph Semischist of Mt. Josephine



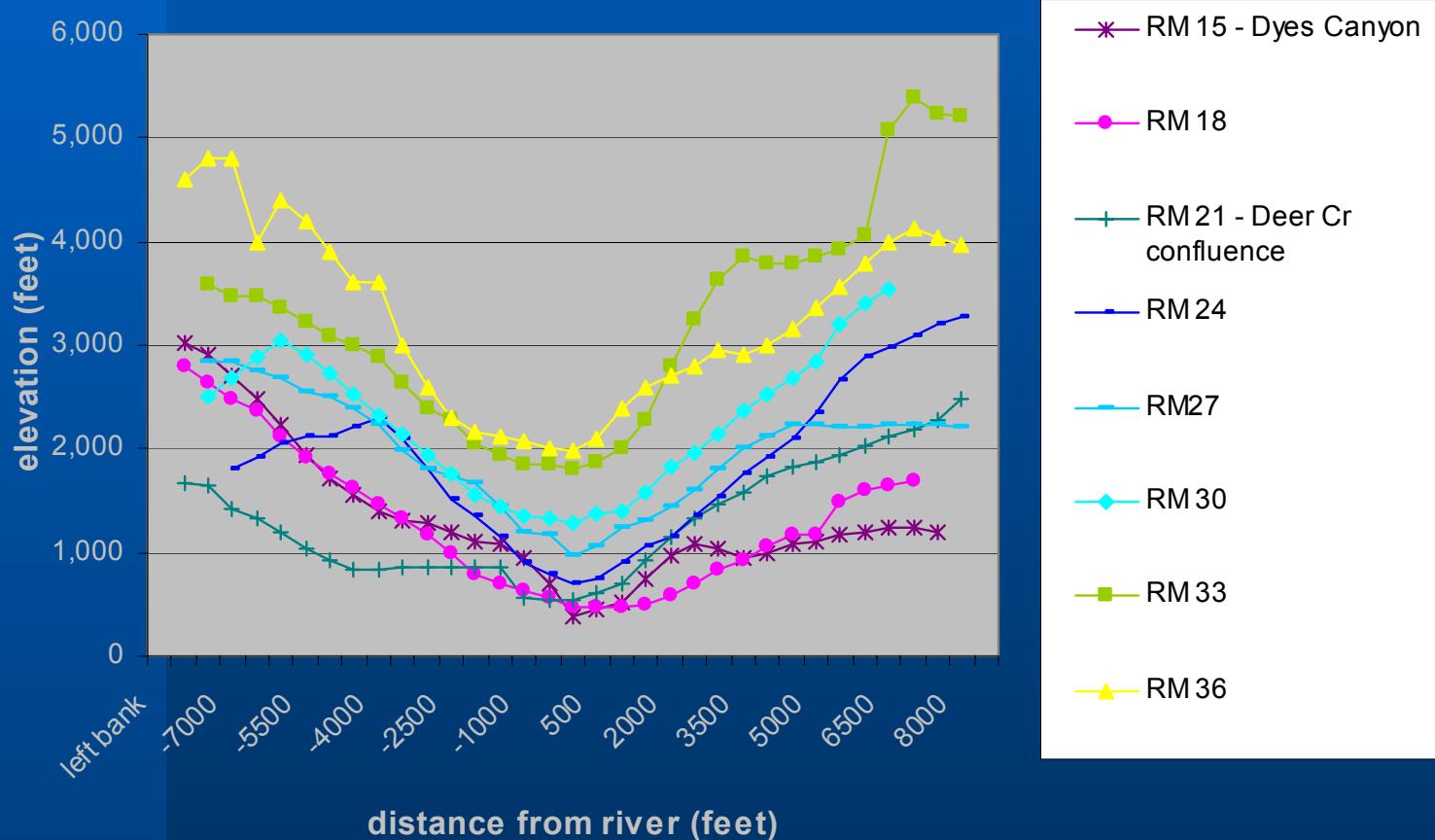
# Upper South Fork Watershed Cross Section River Mile 22- 25



# Lower Valley Cross Sections (below RM 13)



# Valley Cross Sections (3 mile spacing)



# Human Impacts

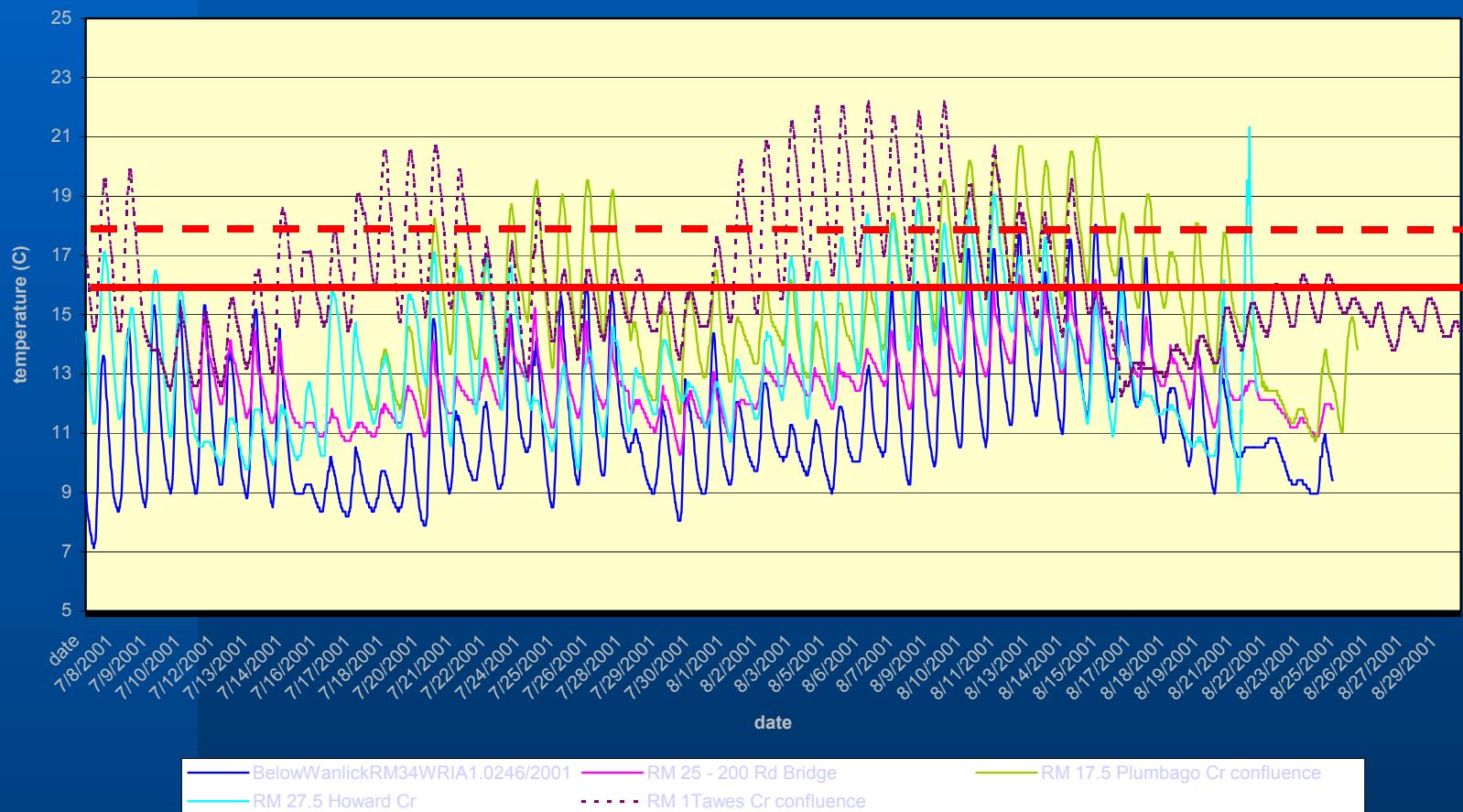
Channel  
straightening and  
armoring

Timber  
harvesting

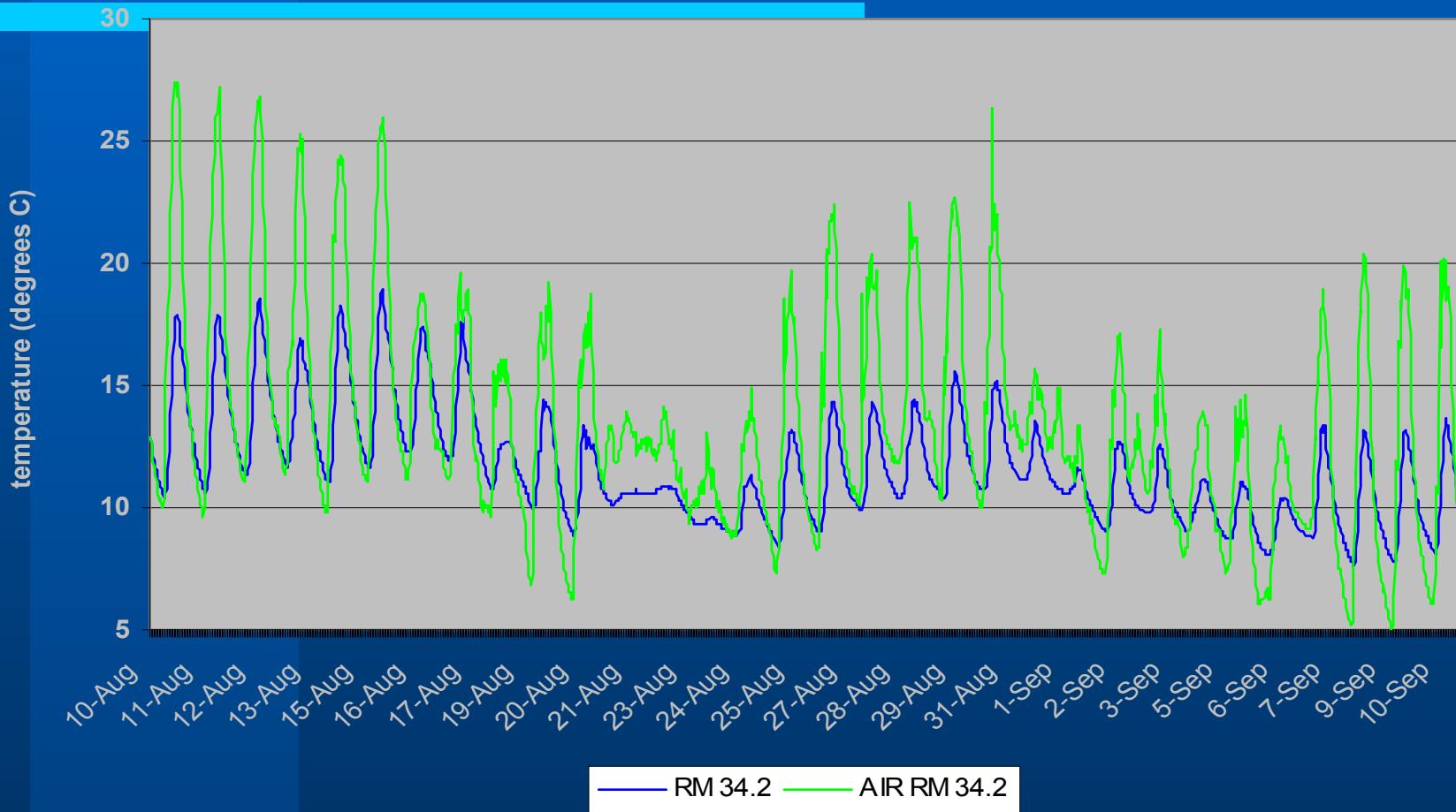
Agricultural  
production



# South Fork Water Temperatures 2001



# Water and Air Temperatures



# FACTORS INFLUENCING WATER TEMPERATURE

Surface water  
flow rate

- Precipitation
- Tributary inflows
- watershed characteristics
- Groundwater discharge



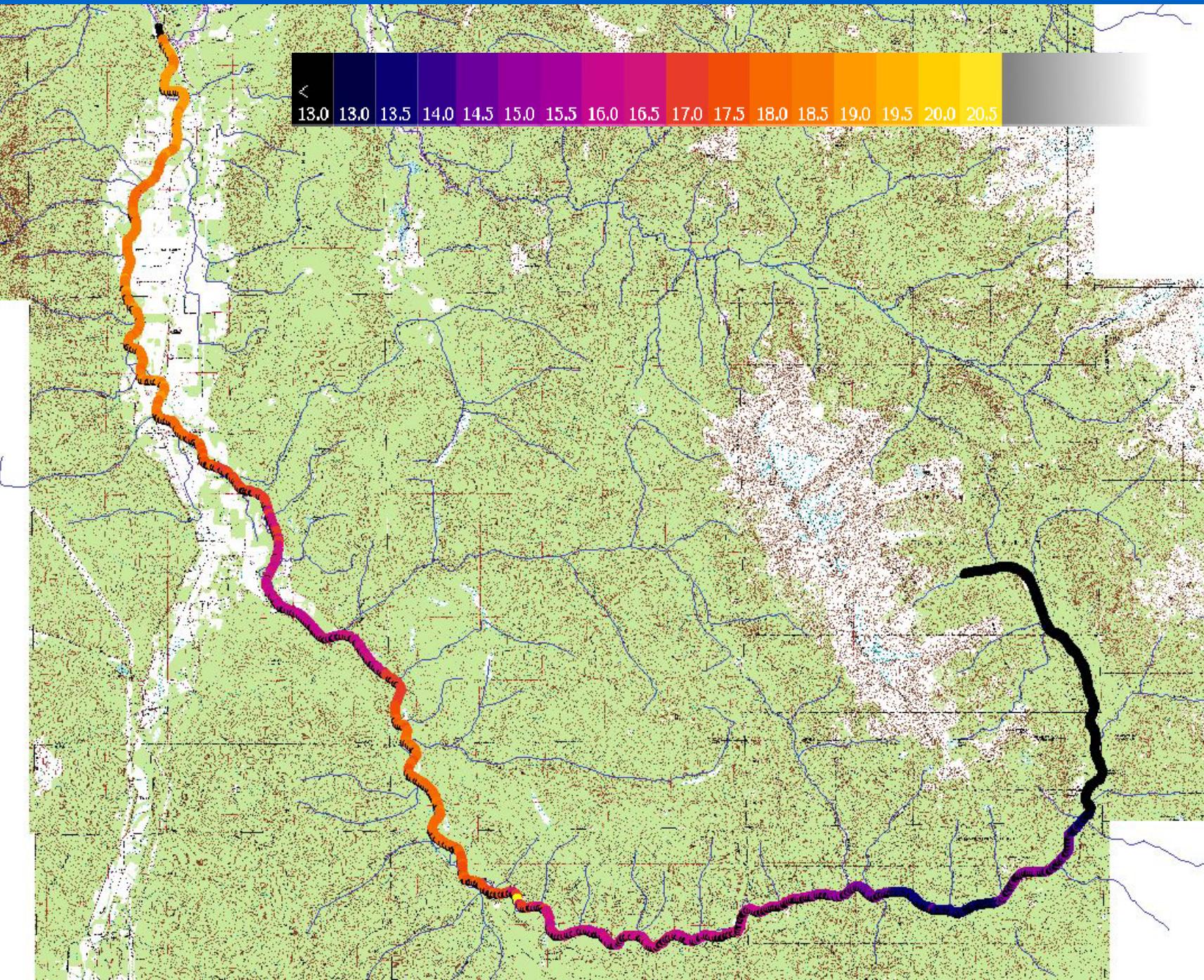
# Data Collected

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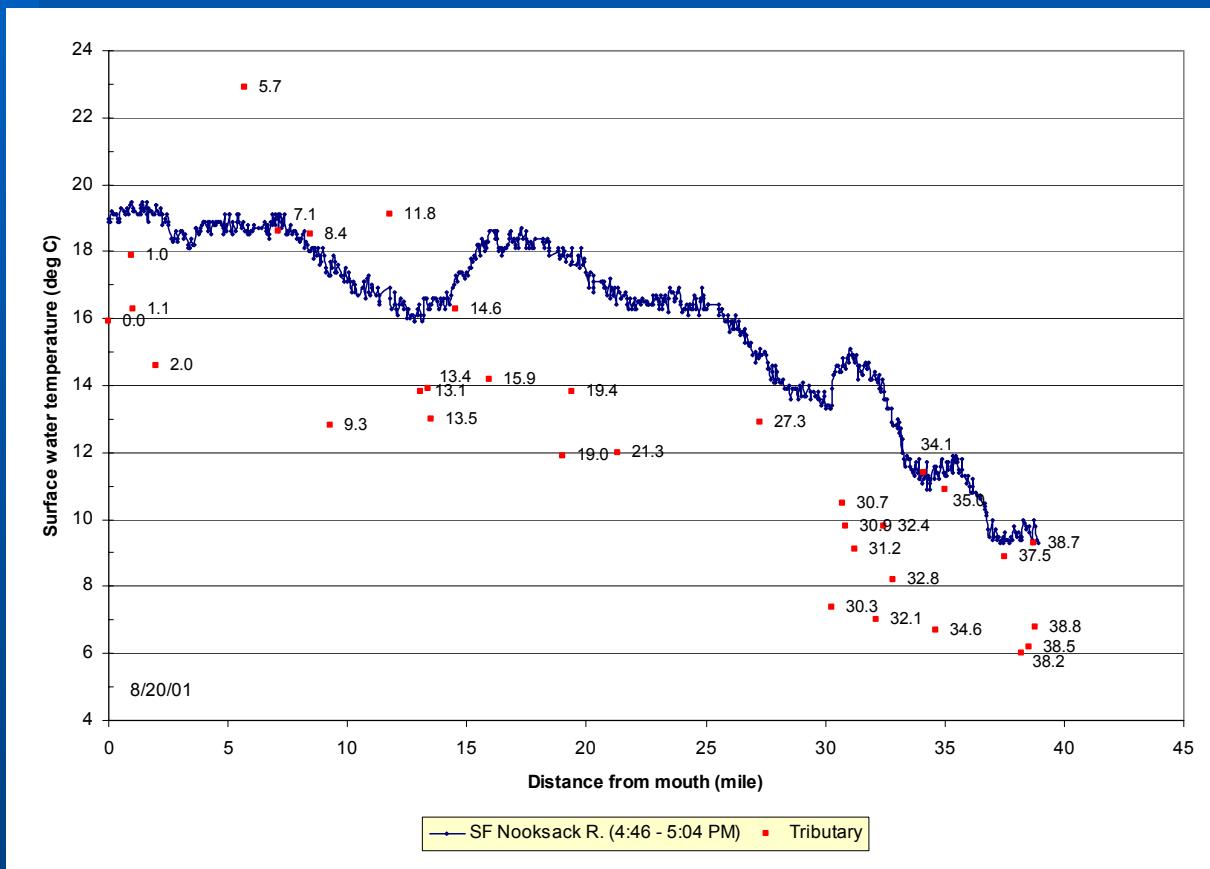
- Water Temperature
  - FLIR single-snapshot measurement
  - Surface Water Temperatures in South Fork over summer months
    - half-hour frequencies
    - Numerous locations in South Fork

# FLIR

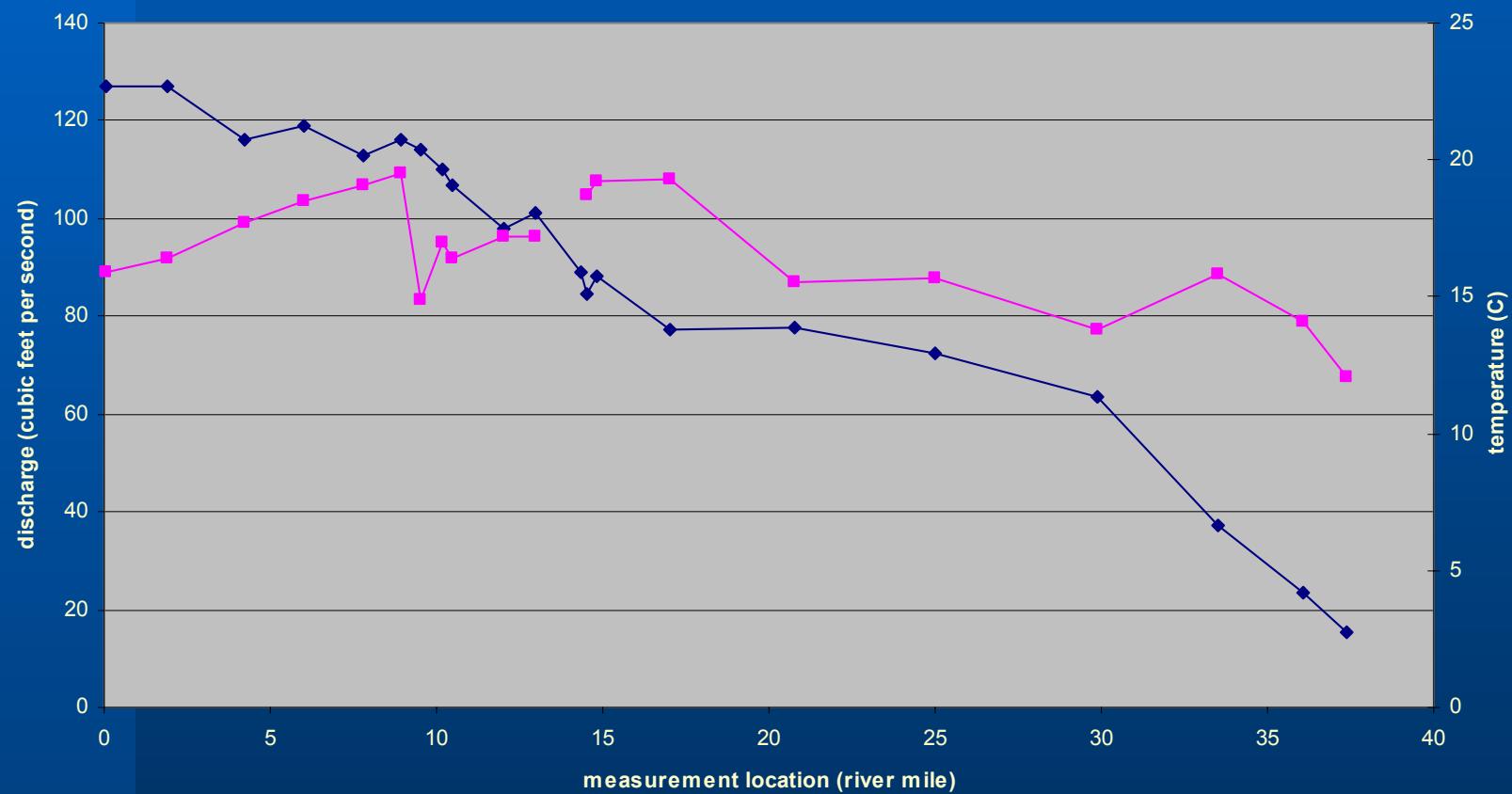
- Detects infrared wavelength radiation emitted from water surface
  - Also detects reflective variation between different surfaces: riffles, pools, vegetation
  - Cannot sense water temp below surface
- 1,500 foot flight elevation
  - Pixel resolution of 1 meter
- Corresponding video images recorded
  - visible wavelength data



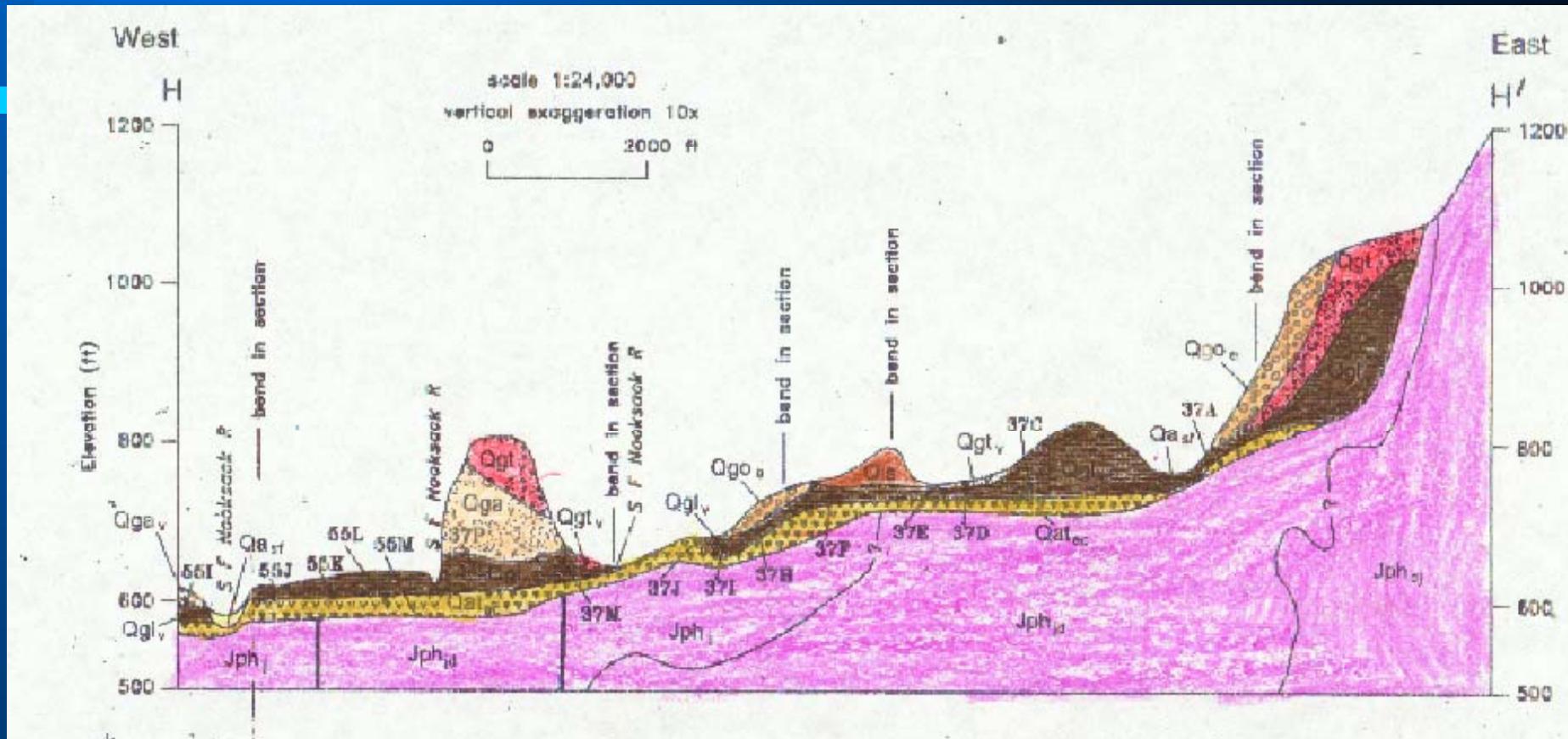
# Longitudinal temperature profile



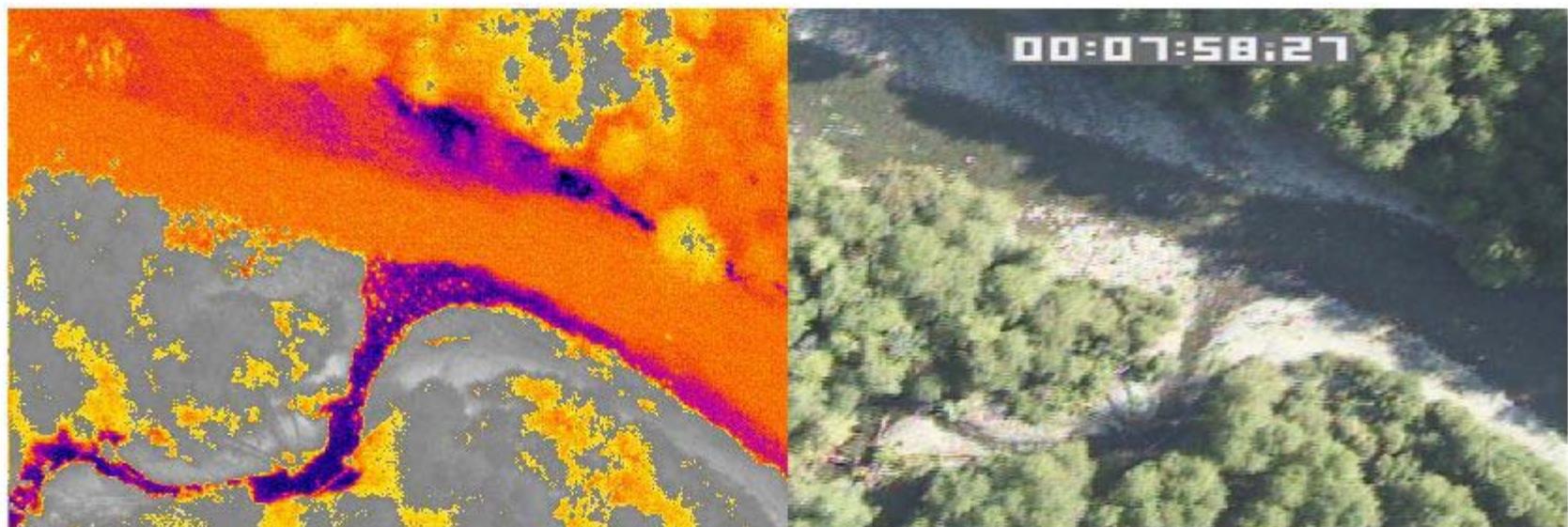
# Seepage Measurement August 25-27, 1998



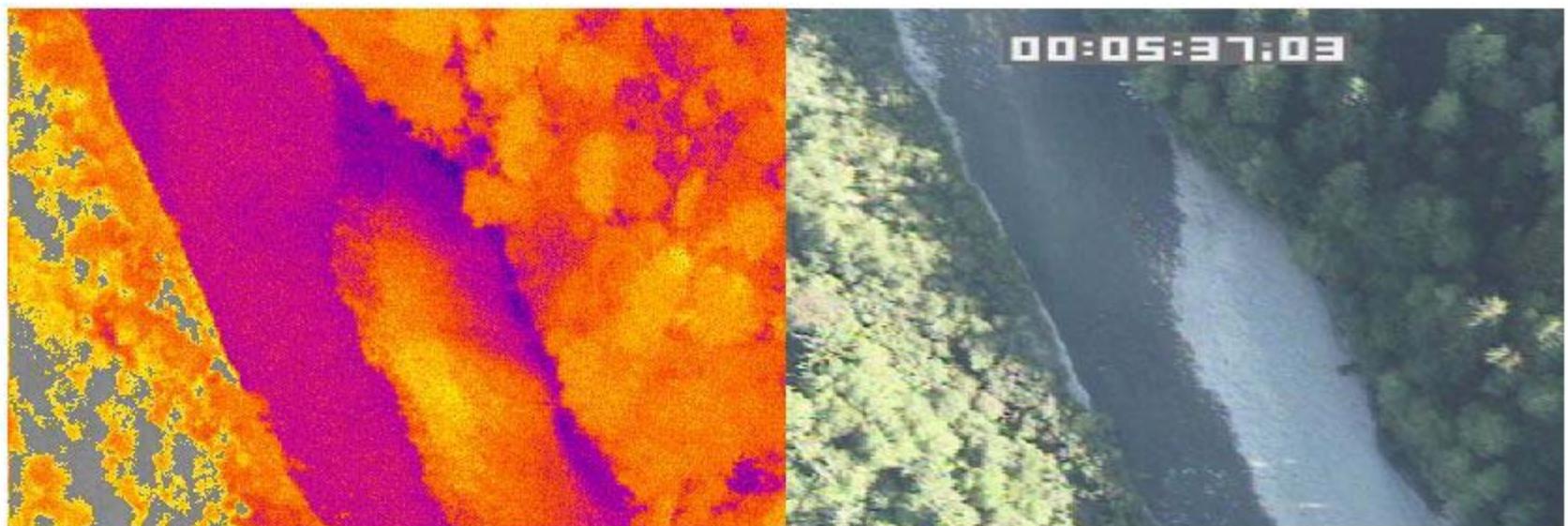
# Upper South Fork Watershed Cross Section River Mile 22- 25



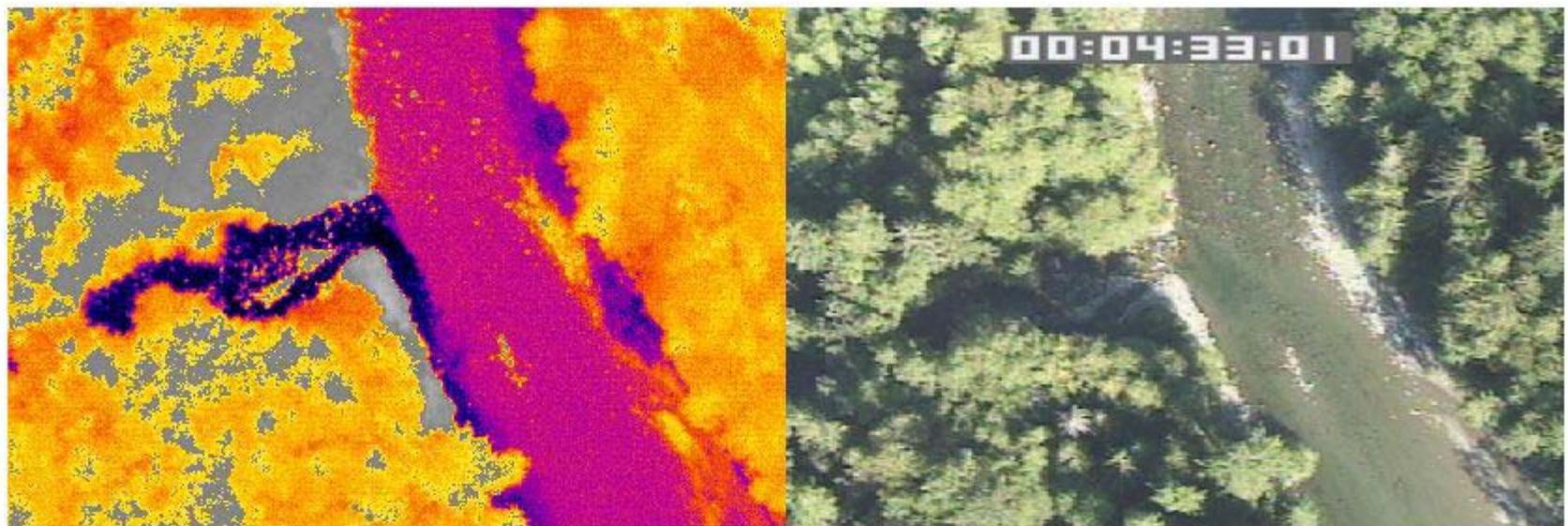
# Cavanaugh Cr confluence (RM 16.5)



# Dyes Canyon RM 15 (above Skookum Cr confluence)

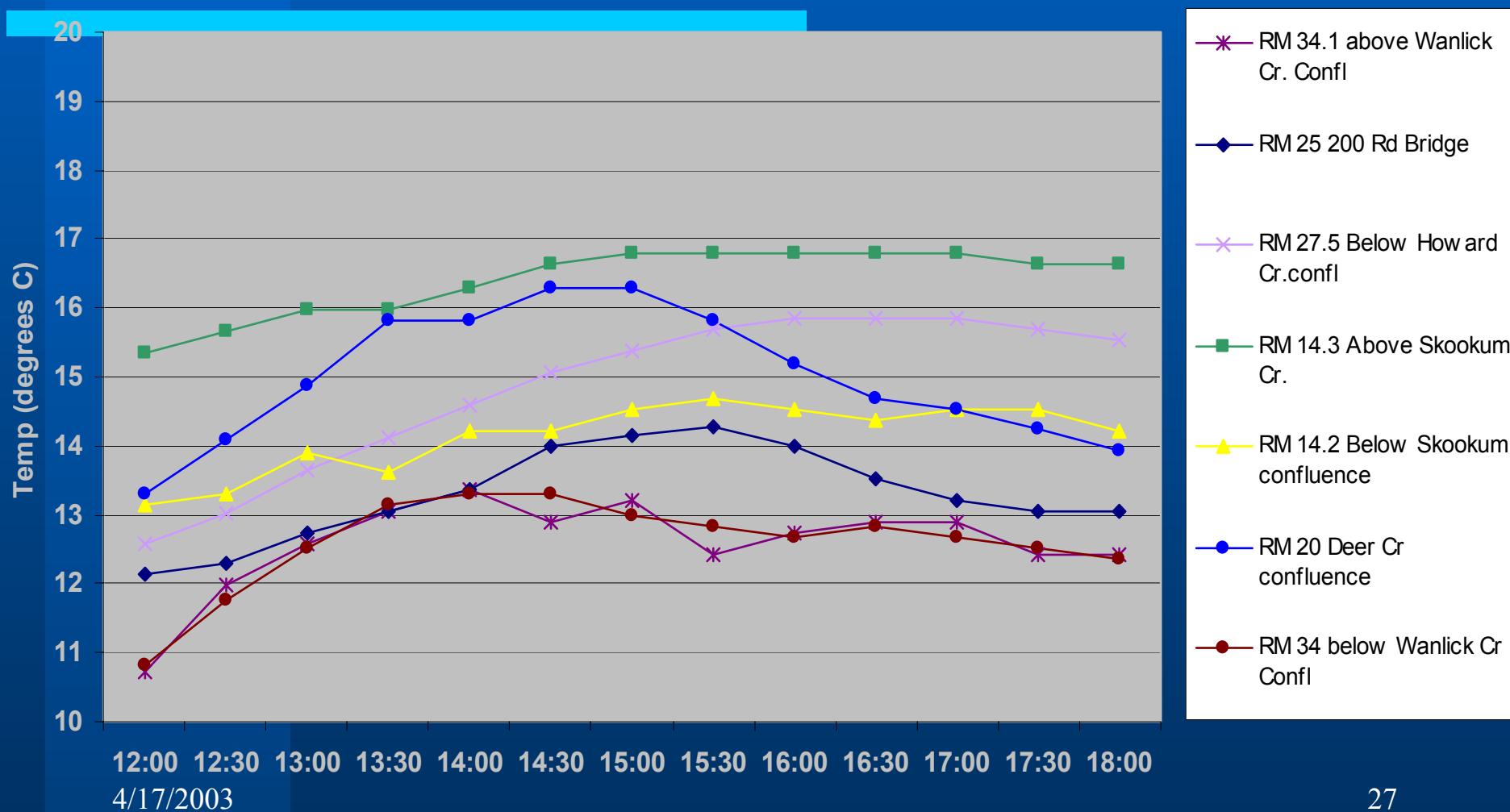


# Skookum Creek confluence (RM 14.3)

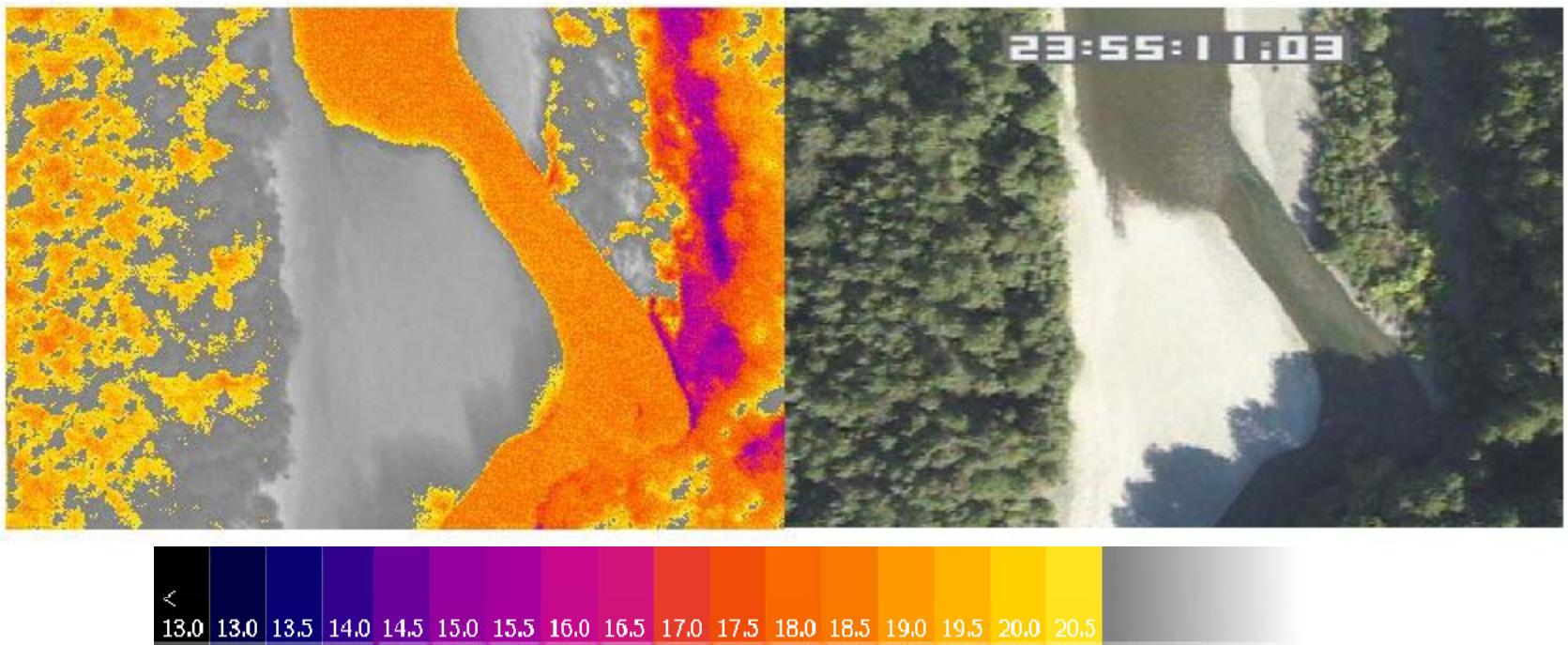


# South Fork Water Temperature

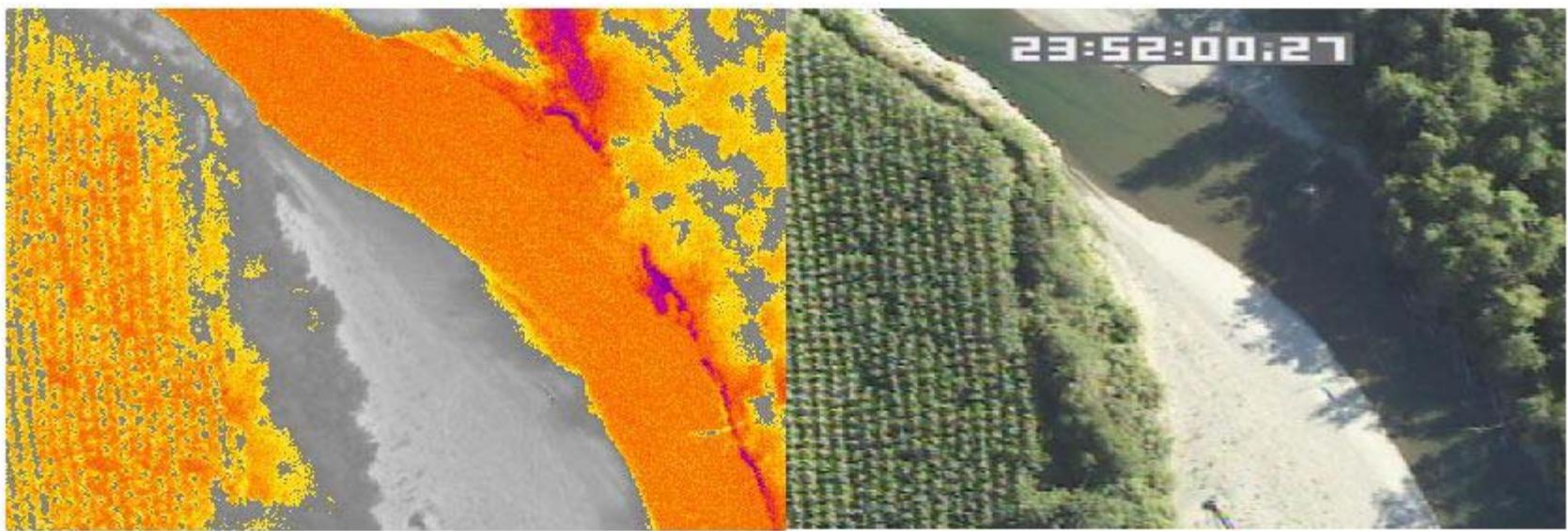
## RM 34.1 to RM 14.2



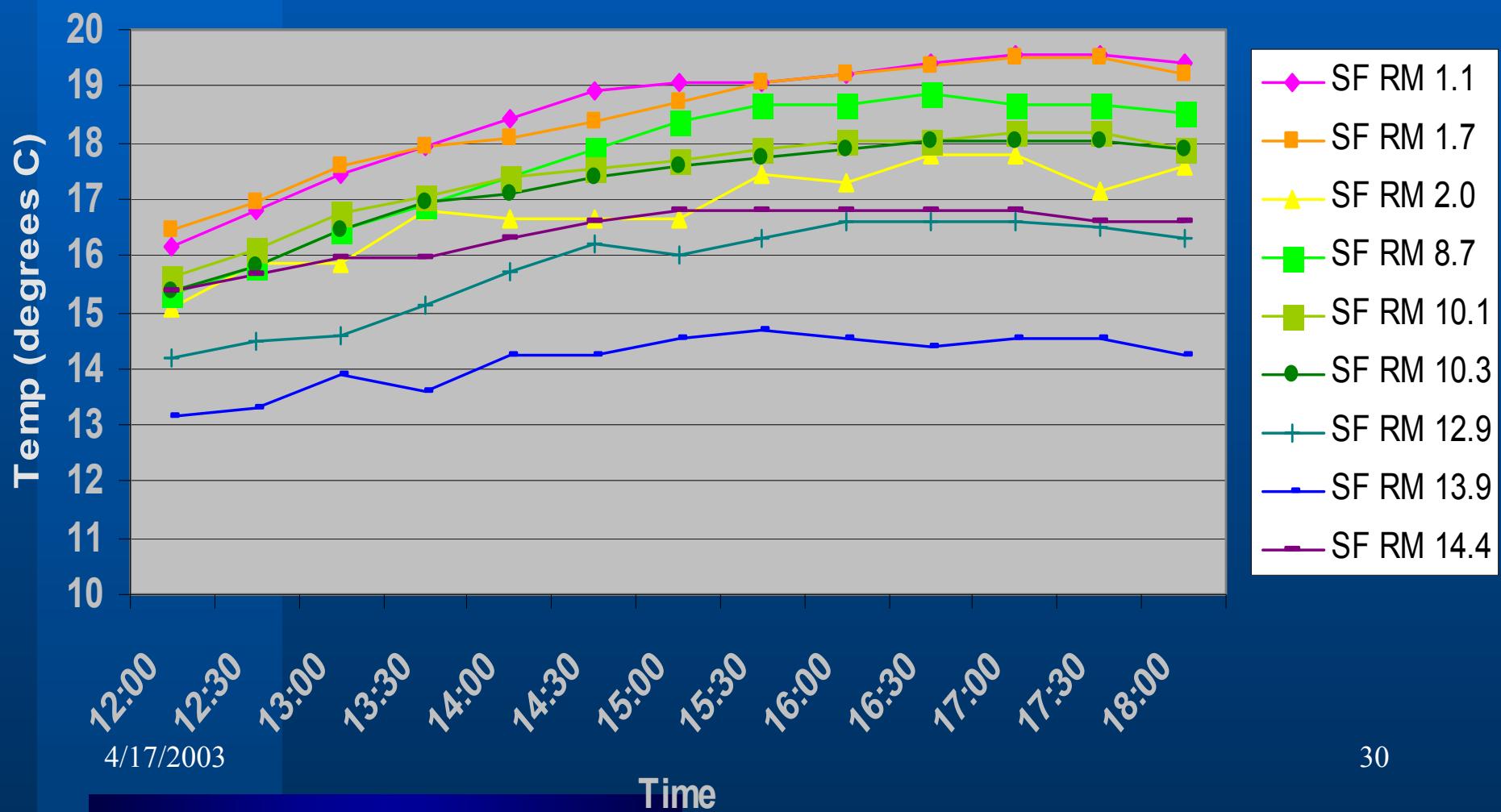
# FLIR image of McCarty Cr confluence (RM 6.6)



# Sygitowicz Cr confluence (RM 3.5)



# Lower South Fork Water Temp



# Summary – Primary Influences of Groundwater on Surface Water Temperature

- **Solar Radiance/ Air temperature**
- **Watershed Characteristics**
  - Gradient of valley and stream channel
- **Groundwater Discharge to Surface water enhanced at topographic/ geologic break**
- **Hyporheic Contribution**
  - Lower Watershed – heat sink/source
  - Upper Watershed – geologically focused